Unconventional Sources of Energy for Millions and Gobar Gas Plant Source of People's Power

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UNCONVENTIONAL SOURCES OF ENERGY FOR MILLIONS

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A study of the present rate of development of the conventional sources of energy in the country in the recent years indicated that our coal, oil and radioactive sources of energy will be exhausted by the end of the present century. In order to meet the increasing demand of energy for agricultural development and in order to solve the socio-economic and environmental pollution problems, the necessity of the development of unconventional sources of energy like, the solar, wind, geothermal and tidal powers has been stressed in the article.

Nearly a decade ago the Advisory Committee on the Application of Science and Technology of the United Nations Organisation under the Chairmanship of Professor M. S. Thacker of India, has identified a number of quite specific areas of research of particular importance for world development, which lend themselves to a large-scale attack. The Committee's report listed a number of research targets including energy and water resources. The committee pointed out that estimates of energy supply indicated that most of the developing countries will apart from water power, or imports of coal and oil, and at some stage, nuclear power have to make use of unconventional sources : the sun the wind, the heat beneath the earth's surface and tides of the sea. The committee urged that effective measures be taken to develop new sources of energy. A brief discussion of the present status and future prospects of the conventional sources of energy in India, and the broad principles of drawing energy from non-conventional power resources is presented in the following paragraphs.

Present Status of the Conventional Sources of Energy in India

India has an enormous field of rural economy on which 80 percent of the population subsists. The rural system has a very low productivity since it has poor power resources available to it. The power resources are mostly non-commercial. These are from firewood and cowdung accounting for 40 and 20 percent respectively of the energy consumption in the country. Apart from these animal power is widely used for irrigation in the rural areas. The irrigation cost per hectare per crop of paddy is estimated as follows for various systems of rural economy-

With bullocks	Rs.	1230/-
Diesel engine pump	Rs.	205/-
Electric pump	Rs.	36/-

Coming to the urban side, the present day resources are largely met from coal and partly from oil and lignite-based thermal stations, from hydrothermal projects and from nuclear reactors.

In his address to the 43rd Annual session to the Central Board of Irrigation and Power, Dr. K. L. Rao, Minister for Irrigation of the Government of India stated that the credit for the 'Green Revolution' is being attributed to new seeds and fertilizers which is a mistaken attribution. He pointed out that we forgot entirely the basic and most important input, namely availability of water. In its absence, the new seeds and fertilizers are futile. The 'Revolution' is entirely due to water and the 'Greenness', due to new seeds and fertilizers. Supply of adequate water, at the critical time, is the essence of irrigation. It is estimated that about 96 million acres are gross irrigated areas at present in India.

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Of this about 28 million acres are from underground water drawn through wells and deep tube wells. Presently about 1.1 million electric pumpsets have been installed consuming nearly 3,300 million units of power per annum which is 9 percent of total commercial power sales in the country. The Government has fixed up a target of 4 million pumpsets for energisation through electric power by 1980.

Future Energy Requirements in India

India is presently producing 15.5 million kw power. By the end of the Fourth Five Year Plan period it is estimated that India will be producing nearly 30 million kilowatts of conventional power through the thermal generators and 3 million kilowatts of power through the nuclear power reactors. The Energy Survey Committee of India estimates energy requirements in terms of coal replacements as 635 million tons by 1975-76 and 895 million tons by 1980-81. It is also estimated that India has to invest Rs. 6, 199 crores by 1973-80 on the development of conventional power resources excluding nuclear power. Also India will be importing Rs. 220 crores of crude oil from foreign countries in the period 1975-76. On 1980, the power per capita in USA will be 14,000 kw hrs per person while in India we have to instal 50 million kw to get atleast 250 kw hrs per person as reported by the Central Board for Irrigation and Power. By then, we will be supplying electricity to 2 lakh big villages each having more than 500 population amounting to two-thirds of rural population.

India is estimated to have 140 million tons of oil, 400,000 million tons of coal, more than three million tons of uranium and 500,000 tons of thorium. The present rate of output of coal and oil deposits in terms of raw products stands around 70 million tons coal equivalent annually. Accounting for an increase in the rate of production of coal, oil etc. and accounting for nearly 9,000 million tons of requirements per decade in the future, India's resources will be exhausted by another half a century.

The coal and oil deposits and hydel resources in the country are occurring in localised regions. The distribution of energy derived from the resources for all India development entails a heavy investment of financial resources in the country. This handicap of geographical imbalance should be countered by the development of units using cheaper energy resources scattered throughout the rural areas on a mass scale.

Socio-Economic Evils of Conventional Sources of Energy

There is also an impounding danger that the atmospheric oxygen in the urban areas is getting depleted at an alarming rate because of the unlimited amount of coal and petroleum waste products from the industrial and thermal power units collecting in the atmosphere, rivers, lakes and oceans.

There is also a socio-economic impact of the use of conventional sources of energy in our country. Because of the change from the hand methods of the predominantly rural life to mechanical methods of manufacturing and the use of electrical energy in every aspect of production of the modern urban life, there is greater mobility of population. Family traditions are affected, because they are no longer united by a need for cooperative production effort, and parents have little opportunity to teach skills to their children, because they are no longer needed in the family function. They are thus learnt away from home, at the school, or on the job. Establishment of the larger industrial centres has led to increased unemployment. If this is to be avoided, our country has to start many local industries in rural areas. These can also absorb local surplus labour and prevent further migration to the towns.

In order to avoid the environmental pollution and to stabilise the vast rural economic system of the country we have to tap unconventional sources of energy.

Solar Energy

It is estimated that in a single desert area of northern Chile some 28,000 square miles annually receive an amount of solar heat greater than all the heat produced in the World during the same period by the burning of coal, oil, gas and wood. At the present time solar energy has greater promise in India and small underdeveloped regions than in large industrial areas where electricity is available at much lower cost. The various fields in which solar power can be put to use are :

Rural Water Supply ;

Solar workers and water heaters ;

Agricultural and industrial drying/space-heating systems ;

Power for running of the Satellite batteries ;

Desalination of water ;

Solar furnaces and Solar engines.

Researches carried out at the Faculty of Sciences, University of Dakar, Senegal have resulted in the construction of a solar motor pump capable of supplying about 40 cubic meters of water per hour for 4 or 5 hours a day. The water, withdrawn from a well at a depth of 10 meters supplies the approximate daily requirement of a community of 500 persons. The area of the solar collector is 300 square meters. In Uzbekistan a solar pump supplies 4-5 cu. m. of water per hour from a depth of 20 meters in the desert. In America a liquid piston solar prime mover is being developed. The mover uses a self-feeding inverted siphon loop with an inert liquid piston whose oscillations transmit the power output to a driver device. Solar energy, collected by a flat collector supplies useful mechanical output.

Under the supervision of the National Physical Laboratory of Israel, intensive experiments on solar heated ponds about 25 metres are being taken up near Atlit, Israel. The operation of the solar pond depends on obtaining a concentration gradient of salt in water ranging from a density of about one at the top to a density of about 1.3 at the bottom of the pond. The bottom of the pond is covered with black butyl rubber or some other absorbing medium so that the salt layer at the bottom heats upto about 90°C. Through careful control of the concentration gradient, mixing within the pond is prevented and convection currrents are reduced to a minimum. The water with lower salt content acts as an insultating layer and contributes to a heating of the bottom layer of the pond. Projections of the capabilities of solar ponds indicate that electric power in the range from 500 to 5000 kw could be produced at less than 2 cents per kw/hr and that the salt could be obtained at a cost of 5-6 dollars per ton, depending upon the concentration of salt in the water supplied to the pond. The water distilled from the pond can be recycled and portions of it used for drinking purposes.

Two systems of large scale solar power plants have been proposed recently in the United States. In the first system by Hilderbrant and Haas of the University of Houston, radiation reaching an area of one square mile would be reflected into a solar furnace and boiler placed at the top of a 1,500 foot tower. The water in the boiler would be boiled to about 1700 degrees centigrade and electricity would be generated by a magneto-hydrodynamic conversion. The electricity thus generated will be utilised for the hydrolysis of water into hydrogen and oxygen which will be stored for recombination in a fuel cell to power a gas-turbine that would drive a generator.

The pond system based on thermal conversion system proposed by Aden and Marjorie Mainel of the Optical Science Centre of the University of Arizona, employs steel collecting surfaces that use the "green house" effect to produce temperatures as high

as 540 degrees. The heat would be transferred to pressured gas and pumped through channels in the steel to a tank, where it would be stored in molten salts. A conventional steam boiler, turbiner and an electrical generating system would be attached to this thermal reservoir, an arrangement that makes possible the continuous generating of electricity. Under this system power could be produced at four to eight paise per kilowatt hour excluding the cost of distribution. It is likely that 500 to 1000 megawatt plants occupying upto 13.5 square miles may be set up in the near future in the south west areas of USA.

In India there is now a great demand for rural electric supply for irrigation purposes. The existing power resources are not sufficient to meet the demand. As such it is suggested that solar plants can be developed on an urgent basis for rural irrigation water supplies. In areas where the groundwater is highly saline, the desalination can also be undertaken producing salt for local needs and potable water for drinking purposes economically.

Wind Power

Wind is the most available and constantly renewed source of energy. Since ancient times it has been made use of by wind mills in many countries. The present development of aerodynamics, extensive research into the entire atmosphere, the experience gained in construction of controlled-speed/ generators and the appearance of new structural materials—all this adds up to open up realistic prospects for the construction of powerful and economically efficient wind-driven power stations (WPS).

The increasing force of wind at higher altitude is of primary importance for solving the problem of utilising wind energy. There is a layer of intensive winds with an average velocity of 20-30 metres per second over any point on the globe (wit h the exception perhaps of the equator). In winter at middle latitudes, the velocity of the wind increases, while the altitude of the layer descends by about a kilometer and a half, which is also quite an advantage for the use of wind for power-generating purposes.

The National Aeronautical laboratory, Bangalore has done notable research on wind power utilization in India. The Laboratory's main activity in regard to utilization of wind power has been concerned with theoretical and practical investigations of various types of wind mills and wind electric generators, study of wind regions in India from the point of view of wind power, design of wind mills suited to wind speeds prevailinng in India, design and manufacture of auxiliary equipment for use with wind electric generators and study of the economics of wind power utilisation.

From the data of hourly wind speeds for 23 stations in India collected from the India Meteorological Department, the frequencies of various wind speeds for each station were computed and used with the performance characteristics of six types of wind electric generators, to estimate the cost per KHW of energy produced by each generator. It is found that for the general wind conditions in India, two machines, the Allagier (7.5 KW and the Elektro WVG-5 (5 KW.) machines will be the most suitable. The cost range per KHW seems to be 15-33 paise.

The economics of WP-2 water pumping windmills installed for supplying water for domestic purposes and small scale irrigation have been analysed with respect to 20 stations distributed over India. Optimum sizes of reservoirs for storage of water have been worked out. It is found that all stations having annual mean wind speed greater than 7.5 kmp the cost of pumping 5 kl of water (1100 gallons) by the WP-2 wind mills with that of diesel pump sets giving the same output shows that the costs in the case of the latter are 2 or 3 times that of windmill pumping.

C. S. I. R. has approved an extension programme of installation and maintenance in a number of villages to demonstrate the economy, simplicity and utility of the wind power plants to the rural community and under this programme 200 windmills have been manufactured and installed. The State Community Departments and Village Panchayats are extending their co-operation by constructing water tanks for storing the water pumped by the windmills.

A number of water pumping windmills have been supplied for installation in Military Farms and Sainik Schools of the Defence Directorate. A few windmills are being tested in Ladakh and other places in border areas. One WP-2 windmill with all accessories and instruction manual are presented to the Imperial Ethiopian College of Agriculture and Mechanical Arts who evinced great interest using the windmills in their country.

At middle latitude at the altitude of 10-12 kilometres, near the upper boundary of the tropopause, constant wind currents were discovered in the recent two decades. Their velocity reaches 70-100 metres per second. The concentration of wind energy at these altitudes is 25 times that of the Earth's surface. Meanwhile the concentration of wind energy in the atmosphere's jet streams surpasses that in the near Earth layer by 500-2000 times.

In Soviet Russia, A high altitude (Tropopause) wind-driven power station (TWPS) has been designed. A set of sails combined with the solid hull of a carrier balloon has been located at an altitude of 8-10 kilometres. The sails protrude outside the balloon. The generator and other electrical equipment is mounted in it as well. The adequate aerodynamic shape of the balloon facilitated the air-borne power generating plant being held in the required position by a wire cable. The latter serves to transmit the generated power to Earth. The TWPS has a capacity of 1500 KW and generates more than 10,000 KWs of electricity a year.

It has been stated by Georgi Yakovlev of USSR that if only a thousandth of wind energy were utilized in the USSR, about 35,000-40,000 million kilowatt hours of cheap electricity can be obtained.

In our country the Wind Power Studies at the National Aeronautical Laboratory must be supported substantially. The utilisation of wind power for rural water supply in irrigation is to be advocated all over the country by the Ministry of Irrigation and Power and a separate factory must be installed in the country for the production of windmills and windmill power plants immediately.

Geothermal Energy

Among the sources of energy available to poorer countries of the world is geothermal steam. A great deal of interest has been created in recent times for exploring the possibilities of harnessing the geothermal energy on a commercial scale from the sources of thermal springs in different countries of the world. In the regions of hot spring, geysers and fumaroles, efforts are being made to find out the possibilities of tapping the geothermal energy from the interior of the earth for power generation.

A world wide study by Prof, George Kiersch of Cornell University, New York states that the potential use of geothermal steam is five or even 10 times greater than the actual use made of it in more than 15 countries, including New Zealand, Iceland, Chile, part of Africa and as well as the Western United States.

The underground steam is used in a variety of ways :-

1. Generation of electricity (more than 800 megawatts are produced every hour, Prof. Kiersch calculates) ;
2. Demineralizing sea water ; and
3. Space heating and industrial process heating.

Condensed steam itself is often a rich source of minerals.

In California, in the region of geysers, a power plant has been functioning since last seven years, generating presently 194,000 KW of electrical energy from super heated steam from the boreholes sunk upto 500-5000 feet depths in the thermal spring sources and surrounding areas. By 1972-75 it is expected about 400,000 KW additional generating capacity will be installed. In New Zealand a plant producing nearly 250,000 KW is in production.

In India, there are about three hundred thermal springs, scattered in different parts of the country out of which a few may be considered as promising for yielding geothermal energy. Preliminary heatflow investigations have been carried out by the National Geophysical Research Institute in Pugga and Manikaran high temperature springs of North India. These have shown that there is a great possibility of encountering high temperatures at workable depths by deep-drilling methods, in the vicinity of the existing thermal springs. Detailed investigations for evaluating the potentiality of these and other thermal spring areas in the country must be carried out in the following manner :

(a) Geochemical prospecting ;

(b) Geological mapping with lithological characteristics of the rock formations ;

(c) Geophysical studies by electrical resistivity, gravity and magnetic methods of prospecting ;

(d) Exploratory drilling accompanied by determination of heat flow in the drill holes.

There is another method of hunting for underground steam brought into light recently by Prof. George Kiersch. This technique makes use of infrared sensing methods from aircraft with which can be mapped possible areas of buried plume or hot water leakage to guide the investigations. This method can be conveniently used in our country.

Tidal Energy

The energy of the ocean tides can be harnessed and converted to electricity by a process similar to that used in the production of hydroelectricity. The size of the tide depends upon the relative position of the Moon and Sun and it also varies with the season and with geographical location. The tides will be high in spring. Studies on the harnessing of tidal energy have been conducted in several countries and only at Rance in France a station is presently being operated with an annual production of 554 million KWH.

There are two processes by which the harnessing can be done. In the one-way cycle process, an estuary or a bay is closed by a barrage to create a large basin. The potential energy of the water is utilised as the basin empties. In the two-way cycle, turbines generate electricity during both filling and emptying stages. With a single barrage, the water falls during the generating phase first from the sea to the basin and then from the basin to the sea. Use could also be made of two adjacent basins each using the simple one-way cycle with one (lower) basin operating during the filling stage, the other (higher) operating during the emptying phase. If both basins are served by plants electrically linked the electricity produced would be more or less continuous.

The Bhavanagar area on the West coast where the difference between the low and high tides is of the order of 37 ft. can be considered as a promising area in our country for a tidal power station.

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GOBAR GAS PLANT
Source of People's Power

By V. APPA RAO

The Gobar Gas Plant was an impressive exhibit at the Khadi pavillion of the Asia 72 Fair in New Delhi. The GGP is a simple method of producing gas from bio-matter, such as cowdung, grain-staiks, vegetable skins and any other decomposable matter. The gas produced by GGP can be directly used as cooking fuel and for lighting lamps. It can be converted into electricity to run engines. The plant not only supplies cheap gas as fuel and power, it also provides very rich manure and acts as a catalyst for helping sanitation and cleanliness of the environment, and improving people's habits.

In India cattle-dung is traditionally used as manure in the field and as fuel in the form of dried cakes. There are areas where cowdung cake is only the source of cooking fuel. The burnt ashes not contain much manurial value as the nitrogen and the much-needed humus is consumed by the fire. The method of preparing and application of cowdung as manure is also very defective, as much of its humus and nitrogenous contents are lost by exposure and absorption. The heaps of cowdung are a veritable eye sore and a breeding ground for so many flies and a cause of environmental pollution. The GGP removes all these bad effects and turns it into a highly rich, fully treated manure for instant use in the farm. All other grain and vegetable refuses can be very profitably used for the production of gas and thus help in the environmental sanitation. Human excreta can be used for it. This will help to make the people latrineminded and stop their habit of defecating wherever they feel the nature's call.

The GGP consumes about 25% of bio-matter for the production of gas and turns out the rest in the form of agreeable slurry, devoid of its foul-smelling gas. The GGP manure is highly concentrated compost manure, the invigorating food for the soil. It helps in keeping the balance of the soil-structure: if the soil is sandy it makes it sticky and if the soil is too clayey it makes it aerated. Thus it helps enhance the soil's capacity to hold water as well as to prevent water-logging. The GGP also increases the value of cowdung; the same amount of cowdung consumed by the GGP produces 25% more manure than it gives by the conventional method of cowdung cakes and cowdung manure.

The Khadi and Village Industries Commission which has taken up GGP as an industry has supplied, till November 1972, over 56,000 plants all over the country. Under a directorate, it promotes, this industry by

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providing training, designing the plants and advancing funds to people. The plants range in capacity from the smallest unit capable of producing 60 cft. of gas to the largest producing 250 cft. of gas and its cost varies from Rs. 1,200 to Rs. 2,500. One can install plant depending on the cattle-heads from 5 to 50 cattle-heads for the supply of dung. Of cource, one can supplement cowdung with night-soil and any available bio-matter including dead animal bodies.

A plant based on 16 cattle-heads produces enough gas to run a 3 H.P. engine for 4 hours and that based on 50 cattle-heads 5 H.P. engine for 8 hours. Internal combustion engines run by petrol or diesel or kerosene can be run by this gas converted into electric power by means of transformers. It is an easily available means of generating power and the user can have his own supply without depending on any outside power agency.

The manure comes out of the GGP fully cured and treated for instant use in the farm. It can be applied at different stages of farming according to the needs of the soil and crops. It can be applied at the time of ploughing the field, at the time of drilling the seeds, along with irrigation water, as a top-dress at the flowering time of the crops, and it can be mixed with chemical fertilisers. This manure can be easily released with the flow of irrigation water. The slurry of the GGP can be used for rapid fermentation of compost of the farmyard manure.

A German agricultural delegation visited India in 1959 and saw these 'gas generators' operating at some places. The members of the delegation were fascinated with these simple plants for generating gas and recommended its large-scale use in the vicinity of water-centres for facilitating maximum use of water resources for farming.

According to the Commission, there are about 222 millions of domestic animals all over India. The use of dung of these animals through GGP could provide domestic fuel to over 22 crores of people and boost up farm production by application of the slurry an increase of 10 million tonnes.

A small GGP unit can be run by a small family using all their night-soil, cowdung and all other bio-matters that are thrown away today to add to the environmental pollution. Its use will give a face-lift to the country-side and make the people sanitation-minded. Large GGP units can be run by big farmers and dairies and cooperatives specially set up for the purpose. It can be very easily and profitably run in hostels, hospitals and hotels in cities to economise their expenditure as well as to be self-reliant in respect of cooking fuel and lighting. The GGP is an answer to the serious power crisis in the country and provide a way out in generating real people's power.